# Meaningful Units of Analysis for Archaeological Niche Models

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**Abstract**

When applied to modelling hominins at the level of the species the application of correlative ecological niche modelling techniques is reasonably uncontroversial – they model the niche space dimensions of the target species (e.g. Neanderthals, *Homo erectus*, etc.). In standard methodologies for correlative ecological niche modelling, the unit of analysis is normally the presence of a species, with the model output representing the contexts in which a species can survive and persist (Hutchinson, 1957; Sillero et al., 2021). But what is the unit in archaeological applications where we are modelling subsets of observations based on material culture? Handaxes, projectile points or maize cobs *per se* are not robust proxies for past 'cultures'. Thus, if these models are meant to capture not past species but past 'cultures', we must engage with recent work critiquing this very notion as used in archaeology (Reynolds & Riede, 2019; Riede et al., 2024). One implication of this taxonomic crisis is that when instead of modelling the presence of a given hominin-as-species we are seeking to model the presence of a specific behaviour as reflected in a given material culture proxy, the model output correspondingly represents only the contexts in which these behaviours are variably favoured. These behaviours are sometimes explicit (maize farming: Vernon et al., 2022; Yaworsky et al., 2024) but often rather more implicit (tool class proxies thought to reflect certain behaviours or populations: Pedersen et al., 2023), but at all times require an assessment defining the behaviour, its relationship to the available predictor variables, and an evaluation of potentially missing causal predictor variables. These models, particularly those where the modelled behaviour is poorly defined, may lead to beautiful yet spurious results in the sense that they do only poorly reflect the true niche dimensions of our target taxa. Due caution and greater clarity is called for, not least because there is at present considerable debate about the applicability or otherwise of correlative models as applied to humans in the context of present and future climate change (Scheffer et al., 2024; vs. Selby et al., 2024).

*References:*

Hutchinson, G. E. (1957). Concluding Remarks. *Cold Spring Harbor Symposia on Quantitative Biology*, *22*, 415–427. https://doi.org/10.1101/SQB.1957.022.01.039

Pedersen, J. B., Assmann, J. J., Normand, S., Karger, D. N., & Riede, F. (2023). Climate Niche Modeling Reveals the Fate of Pioneering Late Pleistocene Populations in Northern

*Speaker

Europe. *Current Anthropology*, *64*(5), 599–608. https://doi.org/10.1086/726700

Reynolds, N., & Riede, F. (2019). House of cards: Cultural taxonomy and the study of the European Upper Palaeolithic. *Antiquity*, *93*(371), 1350–1358. Cambridge Core. https://doi.org/10.15184/aqy.2019.49

Riede, F., Matzig, D. N., Biard, M., Crombé, P., de Pablo, J. F.-L., Fontana, F., Groß, D., Hess, T., Langlais, M., Mevel, L., Mills, W., Moník, M., Naudinot, N., Posch, C., Rimkus, T., Stefański, D., Vandendriessche, H., & Hussain, S. T. (2024). A quantitative analysis of Final Palaeolithic/earliest Mesolithic cultural taxonomy and evolution in Europe. *PLOS ONE*, *19*(3), 1–40. https://doi.org/10.1371/journal.pone.0299512

Scheffer, M., Adger, W. N., Carpenter, S. R., Folke, C., Lenton, T., Vince, G., Westley, F., & Xu, C. (2024). Anticipating the global redistribution of people and property. *One Earth*, *7*(7), 1151–1154. https://doi.org/10.1016/j.oneear.2024.06.008

Selby, J., Hulme, M., & Cramer, W. (2024). There is no human climate niche. *One Earth*, *7*(7), 1155–1157. https://doi.org/10.1016/j.oneear.2024.06.009

Sillero, N., Arenas-Castro, S., Enriquez-Urzelai, U., Vale, C. G., Sousa-Guedes, D., Martínez-Freiría, F., Real, R., & Barbosa, A. M. (2021). Want to model a species niche? A step-by-step guideline on correlative ecological niche modelling. *Ecological Modelling*, *456*, 109671. https://doi.org/10.1016/j.ecolmodel.2021.109671

Vernon, K. B., Yaworsky, P. M., Spangler, J. D., Brewer, S., & Codding, B. F. (2022). Decomposing Habitat Suitability Across the Forager to Farmer Transition. *Environmental Archaeology*, *27*(4), 420–433. https://doi.org/10.1080/14614103.2020.1746880

Yaworsky, P. M., Vernon, K. B., McCool, W. C., Hart, I. A., Spangler, J., & Codding, B. F. (2024). The Goldilocks Zone for maize agriculture and the settlement and abandonment of the West Tavaputs Plateau. *Quaternary International*, *689–690*, 30–42. https://doi.org/10.1016/j.quaint.2023.12.00